Alternative Products to Carbazoles in the Oxidation of Diphenylamines with Palladium(II) Acetate

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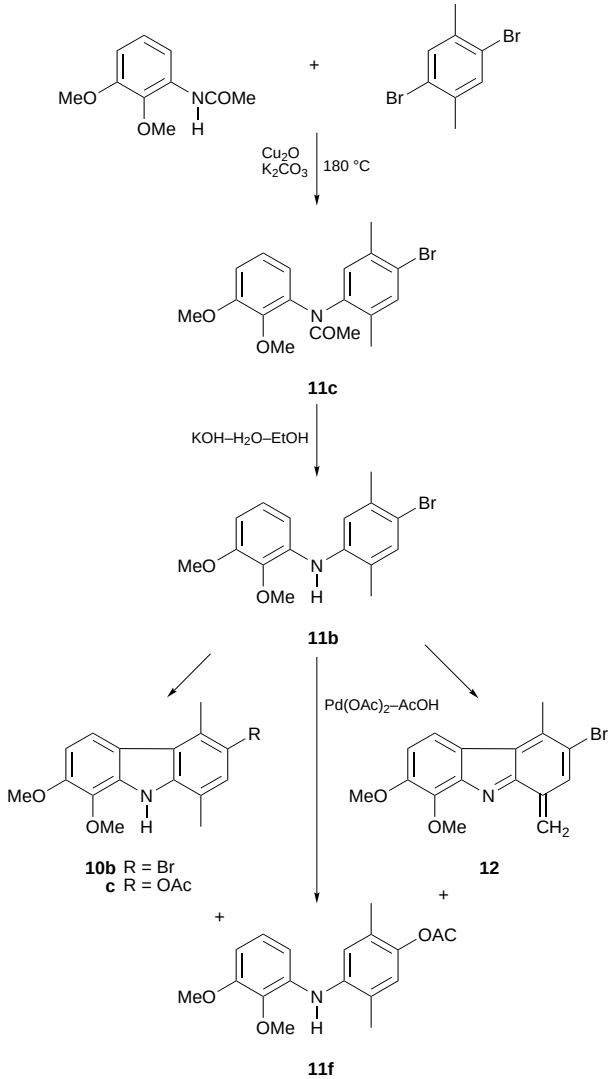
Although simple diphenylamines are conveniently oxidised with palladium(II) acetate to give carbazoles, for more complex examples carbazoles are minor products amongst many.

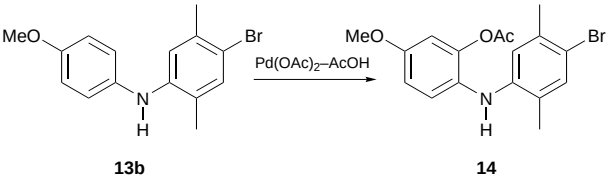
Åkermark *et al.*[1] investigated the palladium(II) acetate cyclisation of several simple diphenylamines to carbazoles, and found that the rate of cyclisation and number of required equivalents of palladium(II) acetate depended upon the electron supply in the aromatic rings. In our studies on ellipticine synthesis, we found that the diphenylamine to carbazole reaction could give alternative products to the required carbazoles:[11] in the present paper we report the results of palladium(II) acetate oxidation on further examples of diphenylamines.

Goldberg coupling of 2,3-dimethoxyacetanilide and 1,4-dibromo-2,5-dimethylbenzene (Scheme 1) gave the diphenylacetamide **11c** (37%), hydrolysis of which (KOH–ethanol–H_2O), gave the amine **11b** (73%). Cyclisation of **11b** with palladium(II) acetate in acetic acid gave the bromocarbazole **10b** (4%), the diphenylamine **11f** (7%), the carbazole **10c** (4%) and the oxidation product **12** (3%), M^+ 333.0194 ($C_{16}H_{14}BrNO_2$). The ^{1}H NMR spectrum of **12** showed only one singlet (3 H) at δ 2.64 and three 1 H singlets at δ 8.17, 8.20 and 8.59, assignable to the methylene and 2-H protons whilst the aromatic protons of ring A gave the expected doublets at δ 7.40 and 7.74.



Scheme 1

The diphenylamine **13b** was prepared by Goldberg coupling of 1-iodo-4-methoxybenzene and 4-bromo-2,5-dimethylacetanilide followed by alkaline hydrolysis of the diphenylamide. Treatment of **13b** with palladium(II) acetate gave the acetoxylated product **14** in 27% yield; the carbonyl absorption at 1638 cm^{-1} indicated that the acetoxy group was in the 2′-position shown (Scheme 2).



Scheme 2

The cyanodiphenylamines **15b**,**d** and **f** were obtained by Goldberg coupling of 4-cyano-2,5-dimethylacetanilide[12] with the corresponding halogenated compounds and alkaline hydrolysis of the intermediate amides **15a**,**c** and **e** in overall yields of 43, 32 and 28% respectively (Scheme 3). Attempted palladium(II) acetate cyclisation of diphenylamines **15b**,**d** and **f** in acetic acid gave the corresponding carbazoles **16a**,**b**,**c** in only very low yields (3–5%) and the products **17a**,**b**,**c** of acetoxylation at the 2-methyl groups (2–6%). The structures followed from the ^{1}H NMR signals of the CH_2OAc methylene groups at δ 5.10–5.16 and the NOE enhancements shown for compound **17a**. When the cyclisation was repeated in trifluoroacetic acid (for **15b** and **15f**) in each case a mixture of phenol **18**[14] and quinone **19** was formed. Mass spectrometric and infrared evidence showed the presence of both components, but the ^{1}H NMR spectrum in $CDCl_3$ indicated the presence only of the quinone imine as a consequence of air oxidation.

Finally, palladium(II) acetate cyclisation of the ester *N*-(4-ethoxycarbonylphenyl)aniline **20**[15] gave only a 37% yield of 3-ethoxycarbonylcarbazole **21**, previously obtained by a different route.[16]

These results illustrate the limitations of the palladium(II) acetate route from diphenylamines to carbazoles, except in the structurally relatively simple cases.

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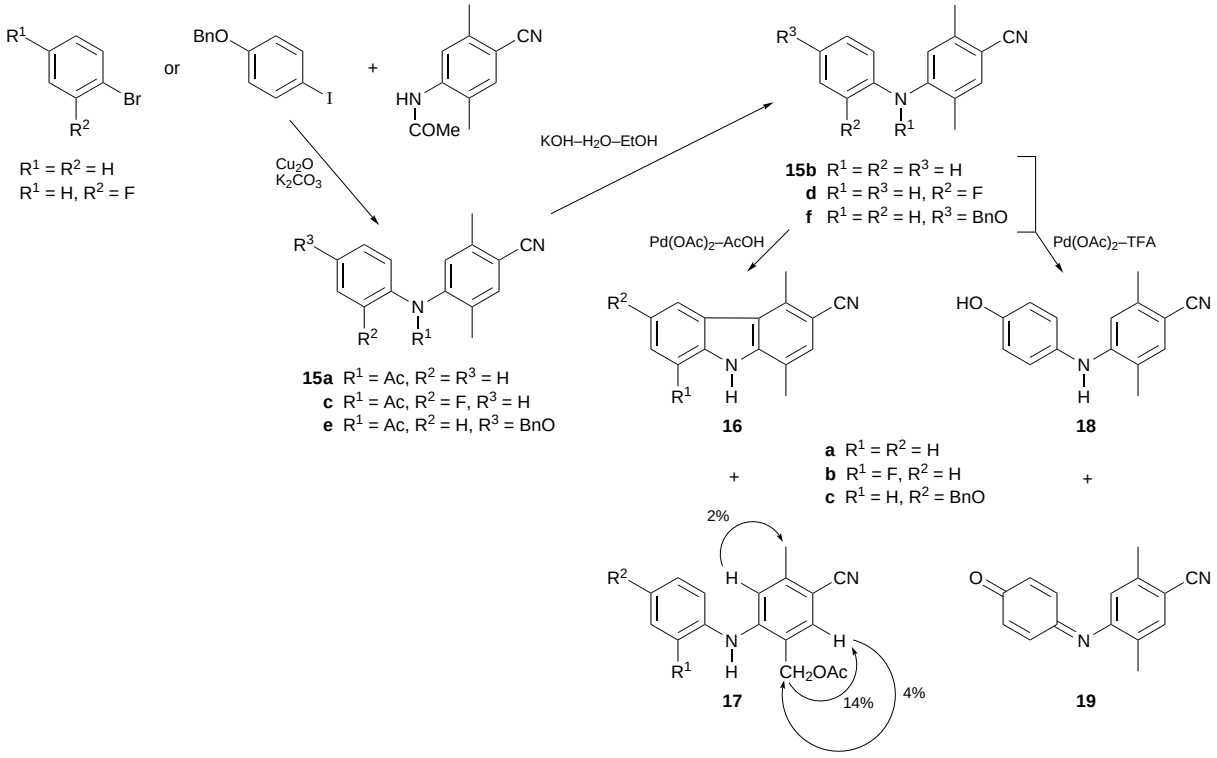
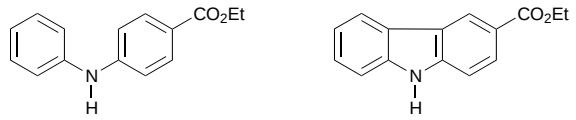


Scheme 3



20 **21**

Techniques used: ^{1}H NMR, IR, UV, MS, elemental analysis

References: 17

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References cited in this synopsis

1 B. Åkermark, L. Eberson, E. Jonsson and E. Pettersson, *J. Org. Chem*., 1975, **40**, 1365.
11 L. Chunchatprasert, P. Dharmasena, A. M. F. Oliveira-Campos, M. J. R. P. Queiroz, M. M. M. Raposo and P. V. R. Shannon, *J. Chem. Res*., 1996, (*S*) 84; (*M*) 630.
12 A. M. F. Oliveira-Campos, M. J. R. P. Queiroz, M. M. M. Raposo and P. V. R. Shannon, *Tetrahedron Lett*., 1995, **36**, 133.
14 J. L. Bernier, J.-P. Hénichart, C. Vaccher and R. Houssin, *J. Org. Chim*., 1980, **45**, 1493.
15 H. Ishu, H. Takeda, T. Hagiwara, M. Sakamoto and K. Kogosuri, *J. Chem. Soc*., *Perkin Trans. 1*, 1989, **12**, 2407.
16 S. G. Plant and S. B. C. Williams, *J. Chem. Soc*., 1934, 1142.